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FORM PTO-1390 (REV 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. § 371		13202.00376
		U.S. APPLICATION NO. 60/152,287 10/070153
INTERNATIONAL APPLICATION NO. PCT/CA00/01002	INTERNATIONAL FILING DATE 1 September 2000 (1.09.00)	PRIORITY DATE CLAIMED 3 September 1999 (3.09.99)

TITLE OF INVENTION
OPTICAL RADIATION SENSOR DEVICE AND USE IN A RADIATION SOURCE MODULE

APPLICANT(S) FOR DO/EO/US
TROJAN TECHNOLOGIES INC.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. § 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. § 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. § 371(f)) at any time rather than delay examination until the expiration of the application time limit set in 35 U.S.C. § 371(b) and PCT Articles 22 and 39(l).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. § 371(c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] A translation of the International Application into English (35 U.S.C. § 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. § 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [X] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. § 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. § 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. § 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. [X] An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. §§ 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information: International Preliminary Exam. Report; International Search Report.

U.S. APPLICATION NO.	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
60/152,287 10/070153	PCT/CA00/01002	13202.00376

17. [X] The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 C.F.R. § 1.492(a)(1)-(5):		
Search Report has been prepared by the EP or JPO ..... **$ 890.00**		
International preliminary examination fee paid to USPTO (37 C.F.R. § 1.492(a)(1)) ..... **$ 000.00**		
No international preliminary examination fee paid to USPTO (37 C.F.R. § 1.492 (a)(1)) but international search fee paid to USPTO (37 C.F.R. § 1.492(a)(2)) . **$ 000.00**		
Neither international preliminary examination fee (37 C.F.R. § 1.492(a)(1)) nor international search fee (37 C.F.R. § 1.492(a)(2)) paid to USPTO **$1,040.00**		
International preliminary examination fee paid to USPTO (37 C.F.R. § 1.492 (a)(4)) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... **$ 000.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$1,930.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ]20 [ ]30 months from the earliest claimed priority date (37 C.F.R. § 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	41-20 =	21	X **$18.00**	$ 378.00	
Independent Claims	4- 3 =	1	X **$84.00**	$ 84.00	
Multiple dependent claim(s) (if applicable)			+ **$280.00**	$ 000.00	
			TOTAL OF ABOVE CALCULATIONS =	$2,392.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. §§ 1.9, 1.27, 1.28).				$1,196.00	
			SUBTOTAL =	$1,196.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ]20 [ ]30 months from the earliest claimed priority date (37 C.F.R. § 1.492(f)).				$ 000.00	
			TOTAL NATIONAL FEE =	$1,196.00	
Fee for recording the enclosed assignment (37 C.F.R. § 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. §§ 3.28, 3.31). **$40.00** per property +				$ 00.00	
			TOTAL FEES ENCLOSED =	$1,196.00	
				Amount to be:	
				refunded	$
				charged	$

a. [ ] A check in the amount of $_____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 50-1710 in the amount of $ 1,196.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-1710. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. §§ 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. § 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO: Patent Administrator
Richard P. Bauer, Katten Muchin Zavis
525 West Monroe Street, Suite 1600
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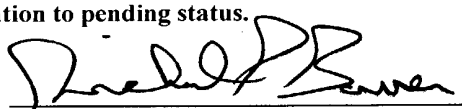
Facsimile: (312) 902-1061



SIGNATURE

Richard P. Bauer — March 4, 2002

NAME — DATE

31,588

REGISTRATION NUMBER

Form #119

13202.00376

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	
	:	Examiner: NYA
MICHAEL SASGES, ET AL.	)	
	:	Group Art Unit: NYA
Application No.: NYA	)	
	:	
Filed: March 4, 2002	)	
	:	
For: OPTICAL RADIATION SENSOR DEVICE AND USE IN A RADIATION SOURCE MODULE	)	March 4, 2002

Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS:

Kindly amend Claims 5-10, 15-21, 26-31 and 36-41 to read as follows. A copy of the Marked-Up Claims is attached for the Examiner's convenience.

5. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

6. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

7. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector is directly mounted to the sensor element.

8. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector is remote from the radiation sensor.

9. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector has a polygonal cross-section.

10. (Amended) The optical sensor defined in any one of claim 1, wherein the radiation collector has a generally circular cross-section.

15. (Amended) The radiation source module defined in any one of claim 11, wherein the at least one radiation source is disposed within a protective sleeve.

16. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

17. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

18. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector is directly mounted to the sensor element.

19. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector is remote from the radiation sensor.

20. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector has a polygonal cross-section.

21. (Amended) The radiation source module defined in any one of claim 11, wherein the radiation collector has a generally circular cross-section.

26. (Amended) The radiation source assembly defined in any one of claim 22, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

27. (Amended) The radiation source assembly defined in any one of claim 22, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

28. (Amended) The radiation source assembly defined in any one of claim 22, where the radiation collector is directly mounted to the sensor element.

29. (Amended) The radiation source assembly defined in any one of claim 22, wherein the radiation collector is remote from the radiation sensor.

30. (Amended) The radiation source assembly defined in any one of claim 22, wherein the radiation collector has a polygonal cross-section.

31. (Amended) The radiation source assembly defined in any one of claim 22, wherein the radiation collector has a generally circular cross-section.

36. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

37. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

38. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector is directly mounted to the sensor element.

39. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector is remote from the radiation sensor.

40. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector has a polygonal cross-section.

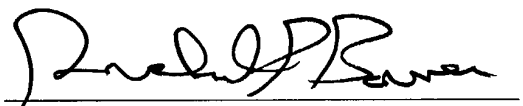
41. (Amended) The fluid treatment system defined in any one of claim 32, wherein the radiation collector has a generally circular cross-section.

REMARKS

Claim 1-41 are pending in this application. Claims 1, 11, 22 and 32 are independent. Claims 5-10, 15-21, 26-31 and 36-41 have been amended to correct their multiple dependency form.

Applicants' undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 625-3500. All correspondence should continue to be directed to our address given below.

Respectfully submitted,



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MARKED-UP CLAIMS

5. (Amended) The optical sensor defined in any one of [claims 1-3] claim 1, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

6. (Amended) The optical sensor defined in any one of [claims 1-3] claim 1, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

7. (Amended) The optical sensor defined in any one of [claims 1-6] claim 1, wherein the radiation collector is directly mounted to the sensor element.

8. (Amended) The optical sensor defined in any one of [claims 1-6] claim 1, wherein the radiation collector is remote from the radiation sensor.

9. (Amended) The optical sensor defined in any one of [claims 1-8] claim 1, wherein the radiation collector has a polygonal cross-section.

10. (Amended) The optical sensor defined in any one of [claims 1-8] claim 1, wherein the radiation collector has a generally circular cross-section.

15. (Amended) The radiation source module defined in any one of [claims 11-14] claim 11, wherein the at least one radiation source is disposed within a protective sleeve.

16. (Amended) The radiation source module defined in any one of [claims 11-15] claim 11, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

17. (Amended) The radiation source module defined in any one of [claims 11-15] claim 11, wherein the radiation collector comprises a distal surface having a generally convex

shape which refracts and reflects the incident radiation along the pathway.

18. (Amended) The radiation source module defined in any one of [claims 11-17] claim 11, wherein the radiation collector is directly mounted to the sensor element.

19. (Amended) The radiation source module defined in any one of [claims 11-17] claim 11, wherein the radiation collector is remote from the radiation sensor.

20. (Amended) The radiation source module defined in any one of [claims 11-19] claim 11, wherein the radiation collector has a polygonal cross-section.

21. (Amended) The radiation source module defined in any one of [claims 11-19] claim 11, wherein the radiation collector has a generally circular cross-section.

26. (Amended) The radiation source assembly defined in any one of [claims 22-25] claim 22, wherein the radiation collector comprises a distal surface having a generally concave

shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

27. (Amended) The radiation source assembly defined in any one of [claims 22-25] claim 22, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

28. (Amended) The radiation source assembly defined in any one of [claims 22-27] claim 22, where the radiation collector is directly mounted to the sensor element.

29. (Amended) The radiation source assembly defined in any one of [claims 22-27] claim 22, wherein the radiation collector is remote from the radiation sensor.

30. (Amended) The radiation source assembly defined in any one of [claims 22-29] claim 22, wherein the radiation collector has a polygonal cross-section.

31. (Amended) The radiation source assembly defined in any one of [claims 22-29] <u>claim 22</u>, wherein the radiation collector has a generally circular cross-section.

36. (Amended) The fluid treatment system defined in any one of [claims 32-35] <u>claim 32</u>, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

37. (Amended) The fluid treatment system defined in any one of [claims 32-35] <u>claim 32</u>, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

38. (Amended) The fluid treatment system defined in any one of [claims 32-37] <u>claim 32</u>, wherein the radiation collector is directly mounted to the sensor element.

39. (Amended) The fluid treatment system defined in any one of [claims 32-37] claim 32, wherein the radiation collector is remote from the radiation sensor.

40. (Amended) The fluid treatment system defined in any one of [claims 32-39] claim 32, wherein the radiation collector has a polygonal cross-section.

41. (Amended) The fluid treatment system defined in any one of [claims 32-39] claim 32, wherein the radiation collector has a generally circular cross-section.

OPTICAL RADIATION SENSOR DEVICE AND USE IN A RADIATION SOURCE MODULE

TECHNICAL FIELD

In one of its aspects, the present invention relates to an optical radiation sensor device. In another of its aspects, the present invention relates to a radiation source module comprising a novel optical radiation sensor device.

BACKGROUND ART

Optical radiation sensors are known and find widespread use in a number of applications. One of the principal applications of optical radiation sensors is in the field of ultraviolet radiation fluid disinfection systems.

It is known that the irradiation of water with ultraviolet light will disinfect the water by inactivation of microorganisms in the water, provided the irradiance and exposure duration are above a minimum "dose" level (often measured in units of micro Watt seconds per square centimetre). Ultraviolet water disinfection units such as those commercially available from Trojan Technologies Inc. under the tradenames UV700 and UV8000, employ this principle to disinfect water for human consumption. Generally, water to be disinfected passes through a pressurized stainless steel cylinder which is flooded with ultraviolet radiation. Large scale municipal waste water treatment equipment such as that commercially available from Trojan Technologies Inc. under the trade-names UV3000 and UV4000, employ the same principal to disinfect waste water. Generally, the practical applications of these treatment systems relates to submersion of treatment module or system in an open channel wherein the wastewater is exposed to radiation as it flows past the lamps. For further discussion of fluid disinfection systems employing ultraviolet radiation, see any one of the following:

United States Patent 4,482,809,
United States Patent 4,872,980,
United States Patent 5,006,244,

United States Patent 5,418,370,
United States Patent 5,539,210, and
United States Patent 5,590,390.

In many applications, it is desirable to monitor the level of ultraviolet radiation present within the water under treatment. In this way, it is possible to assess, on a continuous or semi-continuous basis, the level of ultraviolet radiation, and thus the overall effectiveness and efficiency of the disinfection process.

It is known in the art to monitor the ultraviolet radiation level by deploying one or more passive sensor devices near the operating lamps in specific locations and orientations which are remote from the operating lamps. These passive sensor devices may be photodiodes, photoresistors or other devices that respond to the impingent of the particular radiation wavelength or range of radiation wavelengths of interest by producing a repeatable signal level (in volts or amperes) on output leads.

Conventional optical radiation sensors, by design or orientation, normally sense the output of only one lamp, typically one lamp which is adjacent to the sensor. If it is desirable to sense the radiation output of a number of lamps, it is possible to use an optical radiation sensor for each lamp. A problem with this approach is that the use of multiple sensors introduces uncertainties since there can be no assurance that the sensors are identical. Specifically, vagaries in sensor materials can lead to vagaries in the signals which are sent by the sensors leading to a potential for false information being conveyed to the user of the system.

Accordingly, it would be desirable to have a radiation source module comprising an optical sensor which could be used to detect and convey information about radiation from a number of radiation sources thereby obviating the need to use multiple optical radiation sensors.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a novel optical radiation sensor which obviates or mitigates at least one of the above-mentioned disadvantages of the prior art.

It is another object of the present invention to provide a novel radiation source module which obviates or mitigates at least one of the above-mentioned disadvantages of the prior art.

Accordingly, in one of its aspects, the present invention provides, an optical radiation sensor device for detecting radiation in a field comprising:

a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and

a sensor element capable of detecting and responding to incident radiation along the pathway.

In another of its aspects, the present invention provides a radiation source assembly comprising a protective sleeve containing: (i) at least one radiation source, and (ii) a radiation sensor device for detecting radiation in a field, the sensor device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

In yet another of its aspects the present invention provides a radiation source module comprising a frame having a first support member; at least one radiation source assembly extending from and in engagement (preferably sealing engagement) with a first support member, the at least one radiation source assembly comprising at least one radiation source and a radiation sensor device for detecting radiation in a field, the device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

In another of its aspects, the present invention provides a fluid treatment system comprising an array of radiation sources for generating a field of radiation, the array of radiation sources further comprising a radiation sensor device for detecting radiation in the field of radiation, the sensor device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field of radiation and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

Thus, the present inventors have discovered an optical radiation sensor having a radiation collector for incident radiation which can collect and redirect, as appropriate, incident radiation from a number of radiation sources to a single sensor and convey information about the radiation output of the plurality of radiation sources via a single radiation sensor. Preferably, this is achieved by having a radiation collector at an end of the radiation sensor which has a concave surface or a convex surface. Preferably, if a concave surface is used, the surface additionally comprises a reflective coating to enhance collection of radiation.

As used throughout this specification, the term "concave surface" is intended to mean a surface of a radiation collector which extends into the body of the collector (generally, the surface would protrude proximally with respect to the sensor element). Further, as used throughout this specification, the term "convex surface" is intended to mean a surface of the radiation collector which protrudes out of the collector body (generally, the surface would protrude distally with respect to the sensor element).

Thus, the radiation collector in the present optical radiation source device serves to gather or collect radiation from a predefined arc around the collector and redirect this radiation toward the radiation sensor. When the collector is in the form of a concave surface, a mirror effect may be used to reflect the radiation toward the sensor whereas when the collector is in the form of a convex surface, the incident radiation is refracted, internally reflected or diffused toward the radiation sensor. Preferably, the predefined arc around the collector is a 360° arc although, in some cases, it may be useful and even advantageous to have a single arc of less than 360° or a number of arcs less than 360°C contained within the

field of radiation. Those of skill in art will recognize that the it is not necessary for the predefined arc to be coterminous with the arc of the field of radiation at the plane of radiation incidence.

In a further preferred embodiment, the sensor device is oriented with respect to an elongate radiation source such that the predefined arc referred to above is in a plane which is substantially transverse to the longitudinal axis of the radiation source.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will be described with reference to the accompanying drawings, wherein like numerals denote like elements and in which:

Figure 1 illustrates a schematic of an array of radiation source assemblies in partial section including a radiation source assembly in accordance with the present invention;

Figure 2 illustrates a schematic of a cross-sectional view of an array of radiation source assemblies including a radiation source assembly in accordance with the present invention; and

Figure 3a-3h each illustrate an end view and side elevation view of a number of embodiments of radiation collectors useful in the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figure 1, there is illustrated a trio of radiation source assemblies 120,130,140. These radiation source assemblies could be contained in a radiation source module such as the ones described in the United States patents referred to hereinabove and/or in the radiation source module described in copending United States patent application S.N. 09/258,142 (Traubenberg et al.).

Radiation source assembly 120 comprises a radiation source 122 disposed within a protective sleeve 124.

Radiation source assembly 130 comprises a radiation source 132 disposed within a protective sleeve 134.

Radiation source assembly 140 comprises a radiation source 142 disposed within a protective sleeve 144.

As will be apparent to those of skill in the art, radiation source assemblies 120 and 140 are similar in construction.

Radiation source assembly 130 also comprises an optical radiation sensor 150. Optical radiation sensor 150 comprises a radiation collector 152 connected to a sensor photo-diode 154. Sensor photo-diode 154 is connected to a housing 156. Emanating out of housing 156 is an electrical cable 158. The sensor photo-diode or other sensor material may be chosen from conventional sensors materials. For example, a suitable sensor material is commercially available from UDT Sensors Inc. (Hawthorne, California)..

Disposed between optical radiation sensor 150 and radiation source 132 is a radiation shield 180. Radiation shield 180 serves to block radiation from radiation source 132 being detected by radiation sensor 150.

Radiation collector 152 comprises a concave surface 153. Concave surface 153 has disposed thereon a specularly or diffuse reflective material 156 (e.g., a Teflon™ coating) which serves to reflect incident radiation impinging thereon toward sensor photo-diode 154. Since radiation collector 152 is a solid body, it is preferred that it be constructed from a radiation transparent material (e.g., quartz and the like).

With reference to Figure 2, there is illustrated, in schematic an array of radiation source assemblies 120 and 140 surrounding radiation source assembly 130. As illustrated, a portion of the radiation emanating from radiation source assemblies 120,140 will be that depicted by the dashed arrows in Figure 2. This radiation will impinge on reflective material 155 on concave surface 153 and be reflected toward sensor photo-diode 154. In this manner, optical radiation sensor 150 may be viewed as a "360° sensor" in that it can receive and detect radiation from a substantially 360° plane (2-dimensional) or conoid (3-dimensional) around the collector. This constitutes a significant advance in the art in that the use of multiple sensors can be avoided.

With reference to Figure 3a, there is illustrated an enlarged view of radiation collector 152 shown in Figure 1. Again, it is useful to coat the concave

surface with a reflective material that will reflect incident radiation toward the photo-diode. As illustrated radiation collector 152 in Figure 3a may be constructed from solid quartz and is attached directly to the photo-diode (154).

With reference to Figures 3b-3h, there are illustrated a number of alternate embodiments for radiation collector 152 illustrated in Figures 1 and 3a.

Figure 3b is a modification of the embodiment of Figure 3a wherein the radiation collection and reflection element is not directly connected to the photo-diode. In other words, in the embodiment illustrated in Figure 3b, the radiation collection and reflection element is remote from the photo-diode. Otherwise, the operation of the radiation collector in Figure 3b operates in the same manner as that described hereinabove for the radiation collector of Figures 1-2.

The radiation collector illustrated in Figures 3c-3g share the feature of having a collector with a convex surface. In this instance, a reflective coating is not required. Rather, incident radiation on the convex surface of the collector is redirected to the photo-diode by refraction, reflection and/or both (i.e., a "prism effect"). In essence, Figures 3c-3g illustrate that the particular shape of the convex surface of the radiation collectors not particularly restricted provided that the appropriate refraction or "prism effect" can be achieved to redirect incident radiation toward the photo-diode. Generally, if the cross-section of the radiation collector parallel to a plane of incident radiation is circular (e.g., as shown in Figures 3a-3e), the radiation collector will have a radiation collection arc of substantially 360°. Generally, if the cross-section of the radiation collector parallel to a plane of incident radiation is polygonal (e.g., pentagonal as shown in Figure 3f, octagonal as shown in Figure 3g, triangular as shown in Figure 3h and the like), the radiation collector will have one or more radiation collection arcs of less than 360°.

While the present invention has been described with reference to preferred and specifically illustrated embodiments, it will of course be understood by those of skill in the arts that various modifications to these preferred and illustrated embodiments may be made without the parting from the spirit and scope of the invention. For example, while the present invention has been illustrated with reference to radiation source modules similar in general design to those taught in

United States Patents 4,872,980 and 5,006,244, it is possible to employ the present radiation source assembly in a module such as the one illustrated in United States Patents 5,418,370 , 5,539,210 and 5,590,390 - i.e., in a module having a single support for one or more elongate source assemblies extending therefrom. Further, it is possible to em ploy the present radiation source assembly in a fluid treatment device such as those commercially available from Trojan Technologies Inc. under the tradenames UV700 and UV8000. Still further, while, in the embodiments illustrated and described above, the optical sensor is disposed at the end of the protective sleeve opposite the end where electrical connections for the lamp are located, it possible to locate the optical radiation sensor at the same end as the electrical connections for the lamp thereby allowing for use of the protective sleeve having one closed end. Still further, it is possible to utilize an optical radiation source sensor disposed between two radiation sources, all of which are disposed within a protective sleeve. Still further it is possible to modify radiation collector 152 in Figures 1 and 3a so that the reflective coating is in a number of bands thereby modifying the collector to have one or more radiation collection arcs less than 360°. Other modifications which do not depart from the spirit and scope of the present invention will be apparent to those of skill in the art.

What is claimed is:

1. An optical radiation sensor device for detecting radiation in a radiation field, the device comprising:

a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and

a sensor element capable of detecting and responding to incident radiation along the pathway.

2. The optical sensor defined in claim 1, wherein the predefined arc comprises a substantially 360° arc.

3. The optical sensor defined in claim 1, wherein the predefined arc comprises at least one arc less than 360°.

4. The optical sensor defined in claim 1, wherein the predefined arc comprises two or more independent arcs less than 360°.

5. The optical sensor defined in any one of claims 1-3, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

6. The optical sensor defined in any one of claims 1-3, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

7. The optical sensor defined in any one of claims 1-6, wherein the radiation collector is directly mounted to the sensor element.

8. The optical sensor defined in any one of claims 1-6, wherein the radiation collector is remote from the radiation sensor.

9. The optical sensor defined in any one of claims 1-8, wherein the radiation collector has a polygonal cross-section.

10. The optical sensor defined in any one of claims 1-8, wherein the radiation collector has a generally circular cross-section.

11. A radiation source module comprising a frame having a first support member; at least one radiation source assembly extending from and in engagement with a first support member, the at least one radiation source assembly comprising at least one radiation source and a radiation sensor device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

12. The radiation source module defined in claim 11, wherein the predefined arc comprises a substantially 360° arc.

13. The radiation source module defined in claim 11, wherein the predefined arc comprises at least one arc less than 360°.

14. The radiation source module defined in claim 11, wherein the predefined arc comprises two or more independent arcs less than 360°.

15. The radiation source module defined in any one of claims 11-14, wherein the at least one radiation source is disposed within a protective sleeve.

16. The radiation source module defined in any one of claims 11-15, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

17. The radiation source module defined in any one of claims 11-15, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

18. The radiation source module defined in any one of claims 11-17, wherein the radiation collector is directly mounted to the sensor element.

19. The radiation source module defined in any one of claims 11-17, wherein the radiation collector is remote from the radiation sensor.

20. The radiation source module defined in any one of claims 11-19, wherein the radiation collector has a polygonal cross-section.

21. The radiation source module defined in any one of claims 11-19, wherein the radiation collector has a generally circular cross-section.

22. A radiation source assembly comprising a protective sleeve containing: (i) at least one radiation source, and (ii) a radiation sensor device for detecting radiation in a field, the sensor device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

23. The radiation source assembly defined in claim 22, wherein the predefined arc comprises a substantially 360° arc.

24. The radiation source assembly defined in claim 22, wherein the predefined arc comprises at least one arc less than 360°.

25. The radiation source assembly defined in claim 22, wherein the predefined arc comprises two or more independent arcs less than 360°.

26. The radiation source assembly defined in any one of claims 22-25, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

27. The radiation source assembly defined in any one of claims 22-25, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

28. The radiation source assembly defined in any one of claims 22-27, wherein the radiation collector is directly mounted to the sensor element.

29. The radiation source assembly defined in any one of claims 22-27, wherein the radiation collector is remote from the radiation sensor.

30. The radiation source assembly defined in any one of claims 22-29, wherein the radiation collector has a polygonal cross-section.

31. The radiation source assembly defined in any one of claims 22- 29, wherein the radiation collector has a generally circular cross-section.

32. A fluid treatment system comprising an array of radiation sources for generating a field of radiation, the array of radiation sources further comprising a radiation sensor device for detecting radiation in the field of radiation, the sensor device comprising: a radiation collector for receiving radiation from a predefined arc around the collector within the field of radiation and redirecting the received radiation along a predefined pathway; and a sensor element capable of detecting and responding to incident radiation along the pathway.

33. The fluid treatment system defined in claim 32, wherein the predefined arc comprises a substantially 360° arc.

34. The fluid treatment system defined in claim 32, wherein the predefined arc comprises at least one arc less than 360°.

35. The fluid treatment system defined in claim 32, wherein the predefined arc comprises two or more independent arcs less than 360°.

36. The fluid treatment system defined in any one of claims 32-35, wherein the radiation collector comprises a distal surface having a generally concave shape and further comprises a reflective surface to reflect the incident radiation along the pathway.

37. The fluid treatment system defined in any one of claims 32-35, wherein the radiation collector comprises a distal surface having a generally convex shape which refracts and reflects the incident radiation along the pathway.

38. The fluid treatment system defined in any one of claims 32-37, wherein the radiation collector is directly mounted to the sensor element.

39. The fluid treatment system defined in any one of claims 32-37, wherein the radiation collector is remote from the radiation sensor.

40. The fluid treatment system defined in any one of claims 32-39, wherein the radiation collector has a polygonal cross-section.

41. The fluid treatment system defined in any one of claims 32-39, wherein the radiation collector has a generally circular cross-section.

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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Published:
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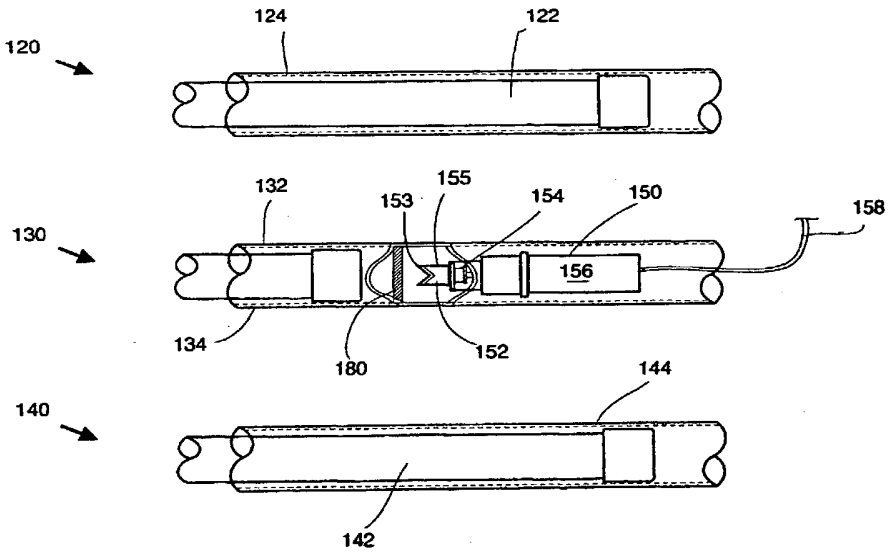
[Continued on next page]

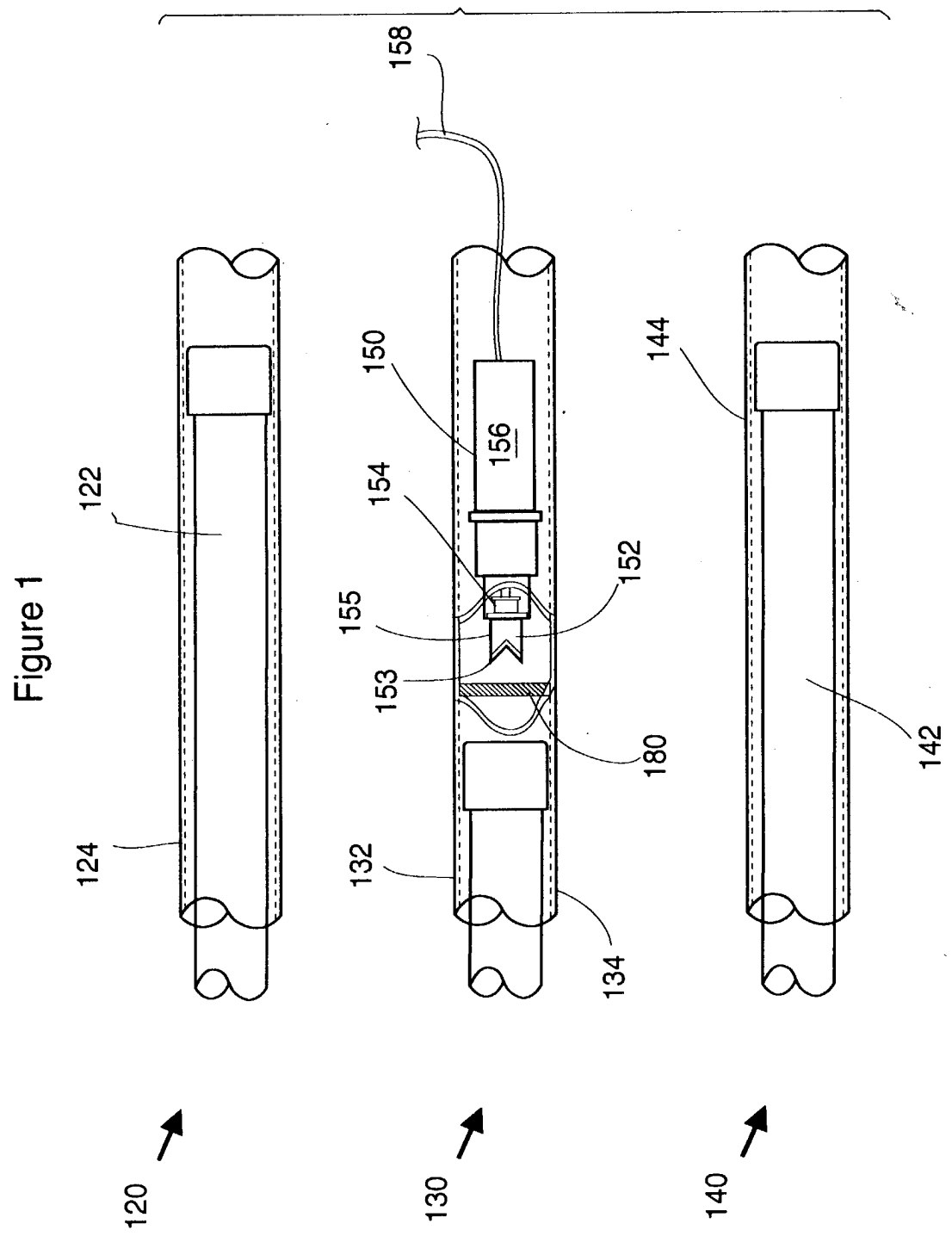
(54) Title: OPTICAL RADIATION SENSOR DEVICE AND USE IN A RADIATION SOURCE MODULE



(57) Abstract: An optical radiation sensor device for detecting radiation in a radiation field, the device comprising: a radiation collector (152) for receiving radiation from a predefined arc around the collector within the field and redirecting the received radiation along a predefined pathway; and a sensor element (154) capable of detecting and responding to incident radiation along the pathway. A radiation source assembly, a radiation source module and fluid treatment system comprising the optical radiation sensor are also disclosed.

WO 01/17907 A1

Figure 1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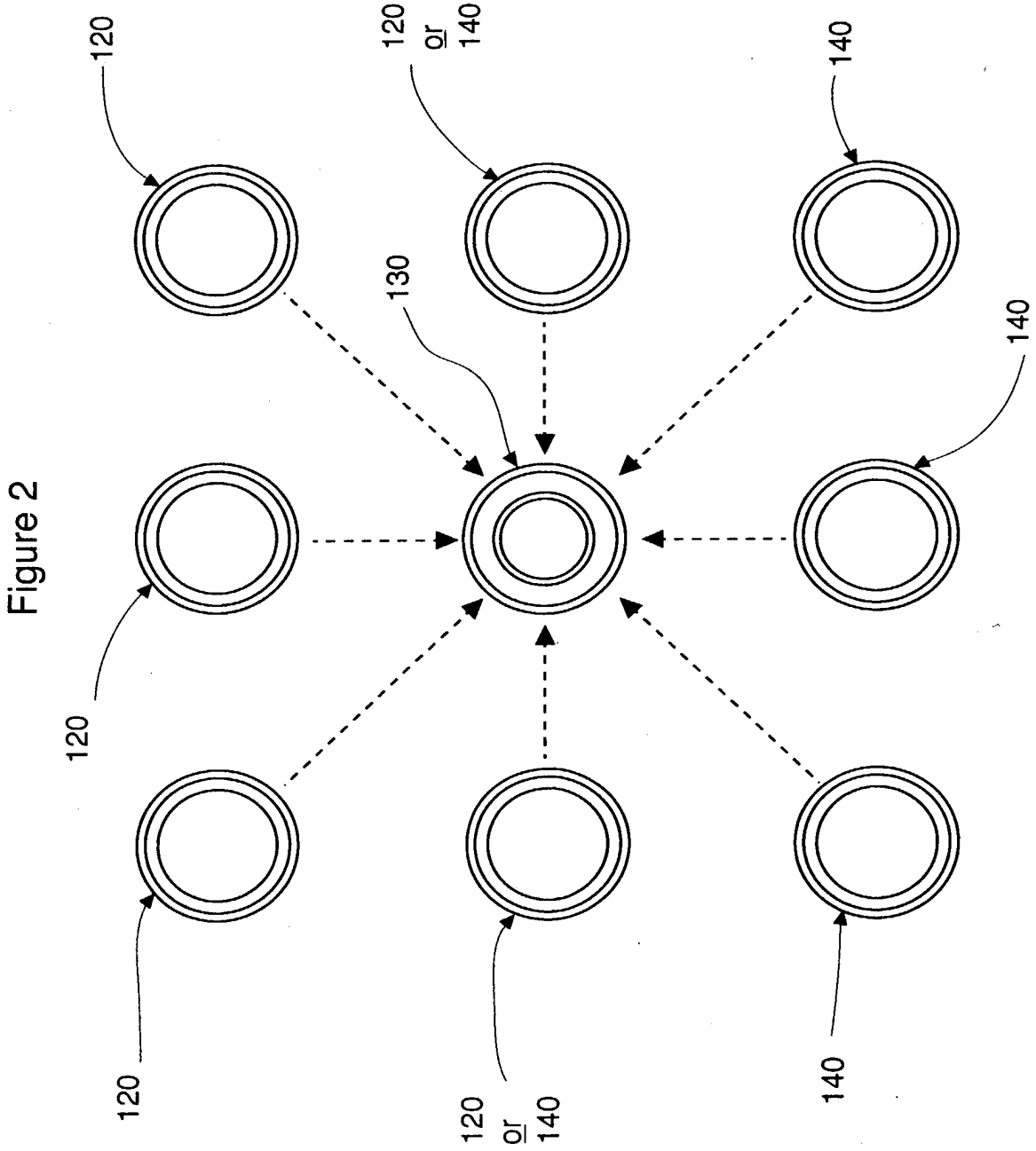


Figure 2

End View Side Elevation

FIG.3A

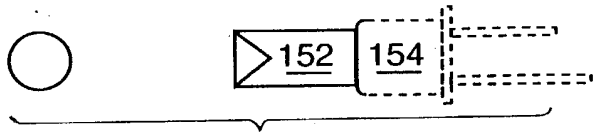


FIG.3B

FIG.3C

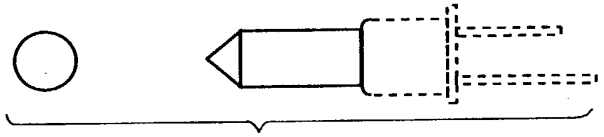


FIG.3D

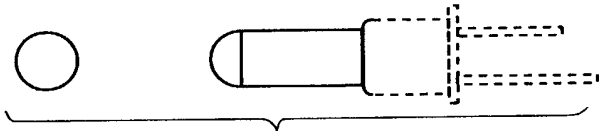


FIG.3E

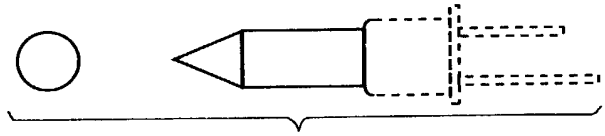


FIG.3F

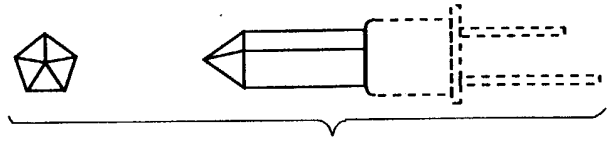


FIG.3G

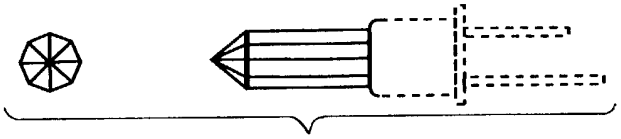
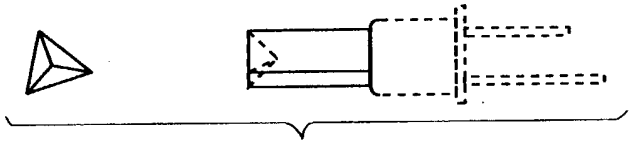


FIG.3H



COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION
(Page 2)

United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112. I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Application No.	Filed (Day/Mo./Yr.)	Status (Patented, Pending, Abandoned)

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KATTEN MUCHIN ZAVIS
Customer Number: 27160

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor Michael Sasges
Inventor's signature _____
Date _____ Citizen/Subject of Canada
Residence _____
Post Office Address same as residence

Full Name of Second Joint Inventor, if any Peter C. Vandoodewaard
Second Inventor's signature _____
Date _____ Citizen/Subject of Canada
Residence _____
Post Office Address same as residence

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(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled OPTICAL RADIATION SENSOR DEVICE AND USE IN A RADIATION SOURCE MODULE the specification of which ☐ is attached hereto ☒ was filed on September 1, 2000 as United States Application No. 10/070,153 or PCT International Application No. _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

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Country	Application No.	Filed (Day/Mo./Yr.)	(Yes/No) Priority Claimed
WO	PCT/CA00/01002	01 September 2000	Yes

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1-00

Full Name of Sole or First Inventor Michael Sasges
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Second Inventor's signature
Date Citizen/Subject of Canada
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Customer Number: 27160

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Inventor's signature _____
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(Page 2)

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